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Assessment of possible factors affecting severity of muscle fatigue among convenience store employees

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Abstract

The *"tingi"* or retail concept has been a part of the Philippine culture. Filipinos embrace the concept since it allows them to buy conveniently at a lower cost and without the pressure of buying in bulk. In addition, due to the rapid growth rate of Retail Industry in the Philippines, retail companies are aggressively expanding its market security by putting up more stores. Given this aggressive expansion, manpower working in convenience stores will also increases and which may result to increase number of employees experiencing muscle fatigue. This study aims to determine the associated possible factors affecting the severity of muscle fatigue experienced by convenience store employees. A survey questionnaire was distributed to one hundred thirty seven (137) respondents. Twelve (12) factors were considered and analyzed using ordinal logistic regression. Results showed that six (6) factors namely, age, length of stay, working hours, type of work (selling area and security) and customer count were significantly contributors to the occurrence and severity of muscle fatigue.

*Keywords:*Muscle fatigue; Ordinal logistic regression

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1. Introduction

The *"tingi"* or retail concept has been a part of the Philippine culture. Filipinos embrace the concept since it allows them to buy conveniently at a lower cost and without the pressure of buying bulk. These traditional retail stores are called *sari-sari* store which means variety store. Commonly, the house owner operates the *sari*-sari store located in his house or within the vicinity. Even the secluded area in the country, the traditional stores can be found.

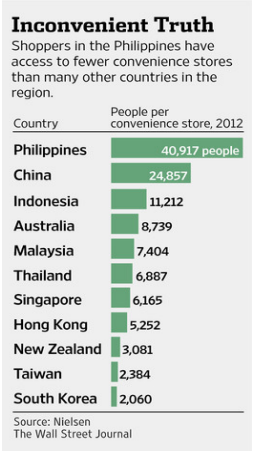
In 1982, a group of businessmen recognized this opportunity and acquired a franchise from the United State which will offer a new retailing concept operating 24/7. The first store was established in 1984 after the businessmen acquired the key knowledge in running the business. Thus, the emergence of the 24/7 stores known as convenience store. *Sari-sari* stores operated only by the house owner is now in competition with the growing number of convenience stores located in strategic place. The convenience stores require at least seven (7) people to operate. As of 2014, the largest convenience store chain in the Philippines operates close to 1300 outlets and with a total workforce estimated to be about 9000 people. Current players in the industry are growing in number with 7-Eleven as the pioneer, following the emergence of Mini Stop, Family Mart, Finds, Circle K, All Day, Lawson and Alfa Mart. All of which has aggressive expansion plan.

The cost of the operating a convenience store is high. Variable costs that contribute to this are electricity and utility expense and most importantly is the cost of labour which requires manpower at different shifting schedules. At any given time, consumers can get and procure most of their basic needs like food, toiletries, supplies and personal effects from any convenience stores. This service level demands a lot of work and commitment from its staff, ensuring that goods are available on time, that staff is always alert and able at any given time of the day. It requires multiple work shifts with varying workloads and demand volumes and the staff has to be both physically strong and mentally flexible to withstand ever changing work conditions. With increasing labour costs today, operations are obliged to maintain a lean workforce at each store.

2012 Nielsen Data posted in The Wall Street Journal shows that shoppers in the Philippines has access to fewer convenience stores with a ratio of 40,000 people is to 1 convenience store as shown in Figure 1.a. On the average, convenience stores has 1500 customers per day. There is still a lot of potential in the growth of the convenience stores as seen in the growth in number of players. The growth is driven mainly due to the increasing wealth of urban Filipinos and the shift in lifestyle brought by the growth of BPO companies which thrives in businesses in Europe and US.

With the growing competition in the country, the old players are starting to respond through aggressive expansion (as shown in Figure 1.b.), product innovation, and loyalty programs. One key resource in keeping in pace with the competition is having trusted and reliable people. For some customers, the sales associates mirror the company. Proper distribution of labour is a must to ensure maximum output is achieved given there is an average of 8 people in a store.

a



b

Fig. 1. (a) Shoppers per Convenience Store; (b) Convenience Store Aggressive Expansion.

Having this potential growth in number of stores (which will result to the increase in number of manpower working in convenience store), this study provides a quantitative approach in determining which factors affecting the severity of muscle fatigue that contributes to the increase of absenteeism rate.

This study aims to (a) determine the causes of fatigue amongst convenience store employees (b) determine the significant factors affecting the affecting the severity of fatigue being experienced by convenience store employees.

2. Methodology

In setting up the study, both quantitative and qualitative approach were used to understand the nature of work, work intensity, work environment and body functions of the convenience store employees. Information and data pertinent to the study were gathered through research surveyfocusing on twelve (12) factors such as, Gender, Age, Weight, Height, Length of Stay, Working Hours, Type of Work, Shift, Number of Hours Standing in a Shift, Average Sales, Customer Count and Store Size. Research survey were in convenience stores located in South Luzon places such as Manila, Makati, Parañaque, Las Piñas, Cavite and Laguna. The result of the research survey were analyzed using the Ordinal Logistic Regression in Minitab software.

2.1. Ordinal logistic regression model

Ordinal outcomes are analysed by logistic regression model. Ordinal logistic regression model is sometimes referred to as the *constrained cumulative logit model* and later called *proportional odds model* (McCullagh, 1980). The most commonly used proportional odds model stated as follows:

$$y_i^* = x_i\beta + \varepsilon_i \tag{1}$$

However, since the dependent variable is categorized, we must instead use:

$$c_x(x) = \ln\left[\frac{P(Y \leq j\,|x)}{P(Y > j\,|x)}\right] \tag{2}$$

and:

$$\ln\left(\frac{\sum pr\,(event\,)}{1-\sum pr\,(event\,)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \tag{3}$$

or:

$$\ln\left(\frac{\sum pr\,(Y \leq j\,|x)}{1-\sum pr\,(Y \leq j\,|x)}\right) = \alpha_j + \beta_i X_{i,1}\,; i = 1, \ldots, k; j = 1, \ldots, p-1 \tag{4}$$

The above equation is an ordinal logistic model for k-predictors with p-1 levels response variables.
Where:
α_j *or* β_0 = threshold
β_i = parameter
$X_{i,1}$ = sets of factors or predictors

3. Results and discussion

The result of the research survey, among the sample of one hundred thirty seven (137) from population size of 208 convenience stores within the scoped area with margin of error of five (5) percent, were analysed using Ordinal Logistic Regression in Minitab software.

3.1. Result of ordinal logistic regression

Table 1 shows the number of observations that fall into each of the categories of the response variable. The ordered response values, from lowest to highest, are also shown in the table. The coding scheme of one (1) being the lowest and five (5) being the highest.

Table 2 shows all categorical factors in the model, the number of levels for each factor and factor level values. The factor level that has been designated as the reference level for each categorical factor is the first entry under *Values*.

Table 1. Response Information.

Response Variable	Value	Count
Severity of Muscle Fatigue	1	4
	2	8
	3	27
	4	48
	5	50
	Total	137

Table 2. Factor Response.

Categorical Factor	Levels	Values
Gender	2	1, 2
Type of Work	4	1, 2, 3, 4
Shift	3	1, 2, 3

The Logistic Regression Table shows the estimated coefficients, standard error of the coefficients, z-values, and p-values of the model. The logit link function is used in the regression analysis, thus calculated odds ratio as well as the 95% confidence interval for the odds ratio are also shown in Table 3.

Table 3. Logistic Regression Table.

Predictor	Coef	SE Coef	Z	P	Odds Ratio	95% CI Lower	95% CI Upper
Const (1)	0.557016	4.46355	0.12	0.901			
Const (2)	1.81416	4.44783	0.41	0.683			
Const (3)	3.48124	4.45102	0.78	0.434			
Const (4)	5.39446	4.46541	1.21	0.227			
Gender							
2	0.254898	0.465319	0.55	0.584	1.29	0.52	3.21
Age	**0.0797481**	**0.0358235**	**2.23**	**0.026**	**1.08**	**1.01**	**1.16**
Weight	0.0075037	0.0116845	0.64	0.521	1.01	0.98	1.03
Height	0.0029327	0.0242891	0.12	0.904	1.00	0.96	1.05
Length of Stay	**-0.147608**	**0.0400082**	**-3.69**	**0.000**	**0.86**	**0.80**	**0.93**
Working Hours	**-0.516797**	**0.220647**	**-2.34**	**0.019**	**0.60**	**0.39**	**0.92**
Type of Work							
2	**0.892621**	**0.448686**	**1.99**	**0.047**	**2.44**	**1.01**	**5.88**
3	-0.634806	0.466828	-1.36	0.174	0.53	0.21	1.32
4	**-2.27400**	**1.15077**	**-1.98**	**0.048**	**0.10**	**0.01**	**0.98**
Shift							
2	0.932636	0.587838	1.59	0.113	2.54	0.80	8.04
3	0.300168	0.422637	0.71	0.478	1.35	0.58	3.09
Number of hours standing in a shift	-0.0639362	0.103901	-0.62	0.538	0.94	0.77	1.15
Average Sales	-0.0000087	0.0000093	-0.94	0.346	1.00	1.00	1.00
Customer Count	**-0.0016337**	**0.0006190**	**-2.64**	**0.008**	**1.00**	**1.00**	**1.00**
Store Size	-0.0006455	0.0032585	-0.20	0.843	1.00	0.99	1.01

The values labelled Const (1), Const (2), Const (3) and Const (4) are estimated intercepts for the logits of the cumulative probabilities of Severity for 1, 2, 3, and 4, respectively. Because the cumulative probability for the last response value is 1, there's no need to estimate an intercept for the value of 5.

Factors such Gender, Type of Work 1 and 3 (Cashier and Backroom) and Shift coefficients (see Table 3) are the estimated change in the logit of cumulative Severity probability when these factors with levels 3 (or 2) are being compared when these factors have only one (1) level. However, there is no sufficient evidence to conclude that Gender, Type of Work 3 and Shift affect the Severity of Muscle Fatigue since their p-values (Gender = 0.548, Type of Work 3 = 0.174, Shift 2 = 0.113 and Shift 3 = 0.478) are greater than $\alpha = 0.05$.

Likewise, factors like Weight, Height, Number of Hours Standing in a Shift, Average Sales and Store Size do not have sufficient evidence to affect the Severity of Muscle Fatigue since, p-value is greater than $\alpha = 0.05$.

But, factors such as Age, Length of Stay, Working Hours, Type of Work 2 (Selling area), Type of Work 4 (Backroom) and Customer Count have sufficient evidence to affect the Severity of Muscle Fatigue since, p-values (0.026, 0.000, 0.019, 0.047, 0.048, 0.008, respectively) are less than $\alpha = 0.05$.

The positive coefficient and odds ratio that is greater than one (1) indicates that higher the values tends to associated with the lower values of Severity of Muscle Fatigue. Factors such as: Age (odds ratio = 1.08) and Type of Work 1 (odds ratio = 2.44).

Next displayed is the last Log-Likelihood (see Table 4) from the maximum likelihood iterations along with the statistic G. This statistic tests the null hypothesis that all the coefficients associated with predictors equal zero versus at least one coefficient is not zero. In the regression model, G = 50.104 with a p-value of 0.000, indicating that there is sufficient evidence to conclude that at least one of the estimated coefficients is different from zero.

Table 5 displays both Pearson and Deviance goodness-of-fit tests. In the regression model the p-value for the Pearson test is 0.000, and the p-value for the deviance test is 1.000, indicating that there is sufficient evidence to claim that the model does fit the data adequately.

Table 4. Log-Likelihood.

Log-Likelihood	-156.389
Test that all slopes are zero:	
G:	50.104
df:	15
P:	0.000

Table 5. Goodness of Fit Test.

	Chi-Square	Df	P
Pearson	659.195	529	0.000
Deviance	312.796	529	1.000

Table 6. Measures of Association.

Pairs	Number	Percent	Summary Measures	
Concordant	4912	74.7	Somer's D	0.50
Discordant	1642	25.0	Goodman-Kruskal Gamma	0.50
Ties	24	0.4	Kendall's Tau-a	0.35
Total	6578	100.0		

The table 6 displays a table of the number and percentage of concordant, discordant and tied pairs, and common rank correlation statistics. These values measure the association between the observed responses and the predicted probabilities.The table of concordant and discordant pairs and tied pairs is calculated by pairing the observations with different response values. Here, we have 6578 pairs of different response values.

For pairs involving the lowest coded response value, a pair is concordant if the cumulative probability up to the lowest response value is greater for the observation with the lowest value. This works similarly for other value pairs. For pairs involving responses coded as 2 and 3 in our regression model, a pair is concordant if the cumulative probability up to 2 is greater for the observation coded as 2. The pair is discordant if the opposite is true. The pair is

tied if the cumulative probabilities are equal. In the study, 74.7% of pairs are concordant, 25.0% are discordant, and 0.4% are ties.

These values are comparative measure of prediction and can be used in evaluating predictors and different link functions. In addition, the summary measures (Somer's D, Goodman-Kruskal Gamma, and Kendalls Tau-α) indicate a better predictive ability of the model.

4. Conclusion and recommendation

Based on the results of the regression analysis, it is observed that there are only six (6) significant factors in the model. There is sufficient evidence to conclude that *Age, Length of Stay, Working Hours, Type of Work 2 and 4(selling area and security) and Customer Count* significantly affects the associated Severity of Muscle Fatigue of convenience store employees.On the other hand, there is insufficient evidence to show that *Gender, Weight, Height, Type of Work 1 and 3(cashier and backroom), Shifts, Number of Hours standing in a shift, Average Sales, Store Size* contribute to muscle fatigue.

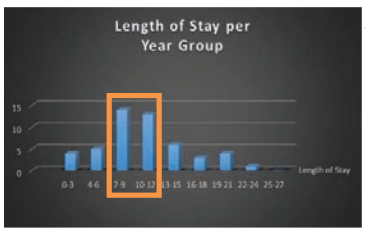
In general, the results of the ordinal logistic regression analysis reflect the actual working conditions in the convenience store. The identified significant factors make sense because based on historical data and actual observations, these factors can be associated with sales associate's muscle fatigue.

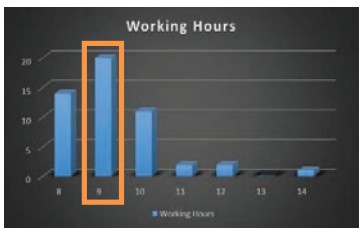
It can be observed in several branches that both males and females are doing the almost same tasks such as cashiering, lifting, stocking in the backroom and others. It only means that in workplace nowadays is not gender specific as long as you can perform the task or job will get the job. Likewise, with the weight and height of employees.

Based on the profile of the respondents who scored the pain the experienced as 5, the average length of stay, number of hour working and age of the sales associates is approximately 10.62 years, 9.29 hours per day and 32.14 years old, respectively. Figures 2.a, 2.b, 2.c show the frequency of respondents' profile.

Hence, cumulative trauma for the employees could possibly explain why this factor is significant in the model. Hence, number of hours standing may also have direct and indirect effects to cumulative trauma but, with no sufficient evidence to conclude the relationship. This cumulative trauma can be reduce and avoided by:

1. *Encourage Early Reporting of MSD Symptoms* - Early reporting can accelerate the job assessment and improvement process, helping to prevent or reduce the progression of symptoms, the development of serious injuries, and subsequent lost-time claims.
2. *Shift Schedule Design:* Optimizing the design of the shift schedule is the most effective way of reducing the health and safety problems. Satisfaction with a particular shift system is the result of a complicated balancing act that is the best compromise for personal, psychological, social and medical concerns.
3. *Length of rest between shifts.*It is recommended that a rest period of at least 24 hours occurs after each set of night shifts. The more consecutive nights worked, the more rest time should be allowed before the next rotation occurs.
4. *Alternative forms of organizing work schedules.*For example, extended work days of ten or twelve hours have been used. It has the advantage of fewer consecutive night shifts and longer blocks of time off.

c.a 

b 

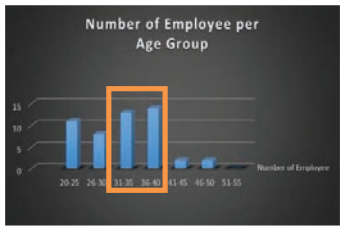
c 

Fig. 2. (a) Length of Stay per Year Group; (b) Working Hours; (c) Number of Employee per Age Group.

However, the additional fatigue from long work hours may also have adverse effects. The physical and mental load of the task should be considered when selecting the length of a work shift.

1. *Education:*Educate employees on the potential health and safety effects of rotational shift work and what can be done to stop these effects. In particular, education in stress recognition and reduction techniques is helpful.
2. *Working time* can be used to address the risks associated with working time include:
   - Develop a working-hours policy on daily work hours, maximum average weekly hours, total hours over a three-month period and work-related travel
   - Eliminate or reduce the need to work extended hours or overtime
   - Design working hours to allow for good quality sleep and enough recovery time between work days or shifts for travelling, eating, washing and sleeping
   - Eliminate or reduce the need to work long shifts for more than three consecutive days
   - Schedule work for hours when the risks may be lower – For example, complex and safety-critical tasks are best undertaken during normal day shifts when workers are less likely to be fatigued.

Since convenience store, the employees must attend to the needs of every customers. Thus, it is logical to think that the number of customers has an effect to the severity of sales associates' muscle fatigue.

Moreover, 70%-80% of the sales of a convenience store is coming from the selling area where customers get the products they want thus, it has a need for security for products will not be taken away for free. Muscle fatigue and risk of accidents can be avoid through:

1. Usage of proper tools like footrest, floor mats, and proper foot gear can help reduce risks. The use of a footrest reduces intervertebral disc stress by preventing excessive lordosis or "swayback" where spine tends to bend. (Whistance, Adams, van Geems & Bridger, 1995).
2. Usage of floor mats which was recommended by Cham and Redfern (2001) increases elasticity thus decreasing energy absorption. There is less friction and less stress resulting in lesser discomfort and fatigue. Also, to minimize the pressure, use of proper shoes that mold one's feet is recommended. There is a swelling of feetduring standing; thus, it's best to purchase one-half to one size larger than the actual foot size. A good time to purchase is right after one has been standing for a lengthy period of time (Konz & Johnson, 2000).

While Type of Work (backroom) and Shift are not significant due to tasks done inside the store stretched and distributed throughout the day. For example, for an 8 hour shift will be assigned to do cashiering, replenishment of stocks, paper works and others. Tasks will be depended on the shift that you will be assigned like, Morning Shift (in most cases) 90% of your time will be devoted to Cashier, Swing 30% of your time will spend cashiering, 30% will be on replenishment and 40% cleaning of machines.

Lastly, Store size and Average sales are not significant due to regardless of size and average sales will be doing the same tasks in your shift whether it is high volume or low volume store (High volume means with average sales of Php. 90,000 per day and Low less than Php. 30,000 per day).

Acknowledgement

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Appendix A. Sample of a Convenience Store Layout

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